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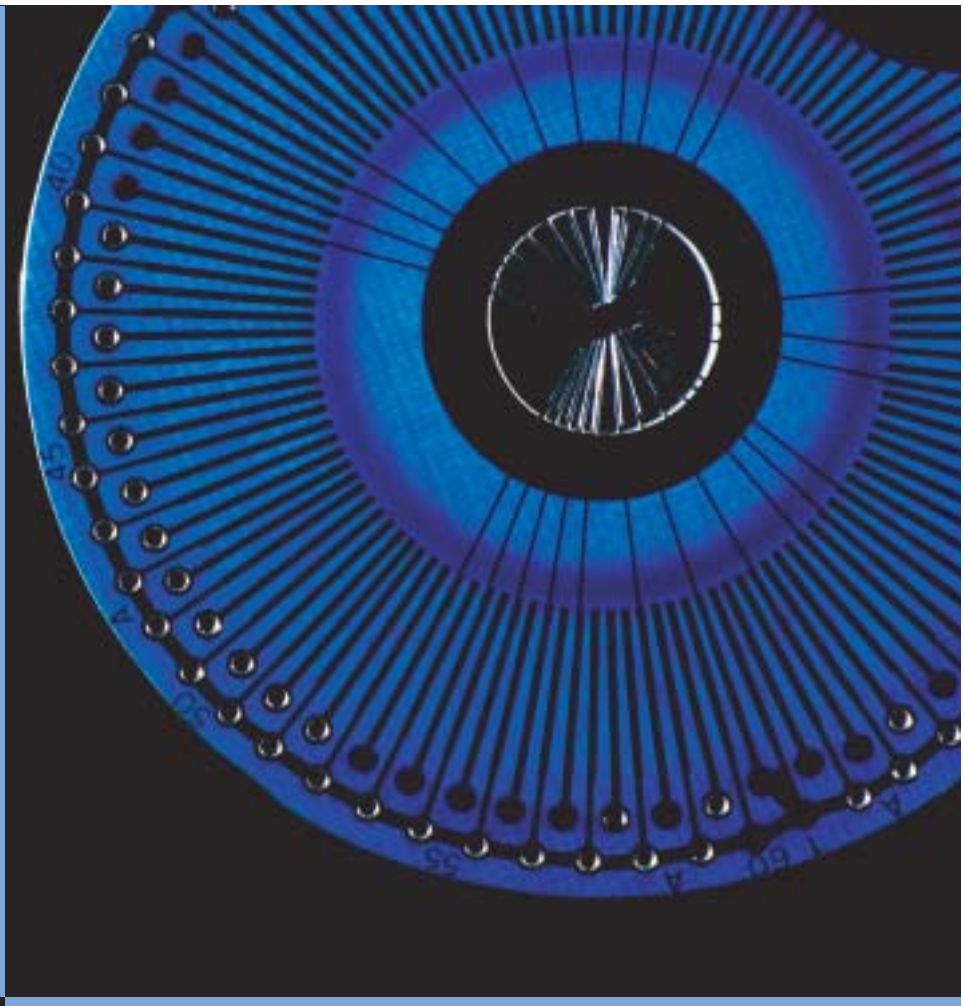

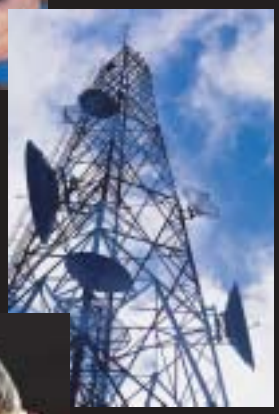

Science and Technology: The Key to Creating Prosperity

A Briefing Report for the Science and Technology Economic Prosperity Forum

April 15, 2004

SCIENCE AND TECHNOLOGY: THE KEY TO CREATING PROSPERITY

PREFACE

Since the early 1990's, San Diego has transformed itself into a world leader in biotechnology, digital wireless communication, high definition digital technology, medical imaging, materials science technology and life enhancing technologies. Given the importance of these industries to the region's economy (discussed below) and considering the rapid evolution of the science and technology marketplace, the City Council established the San Diego Science and Technology Commission (SDSTC) in May of 2000. The City Council established the SDSTC to serve in an advisory capacity to the Mayor, City Council, and City Manager on policy issues related to science and technology industry. The Commission strives to examine important issues related to both traded science and technology industry clusters and scientific research institutions. The SDSTC's focus is to provide useful information and make policy recommendations to help ensure that San Diego continues to support and grow these important industries.

In late fall of 2003, the SDSTC developed the idea for a science and technology industry forum where key representatives from the private sector, government and education could gather to discuss the state of science and technology industry in the City. The SDSTC hoped that this forum would illuminate the positive economic influence of the science and technology industry and facilitate thoughtful discussion around important industry issues. In order to optimize the planning and information shared at the forum, the SDSTC partnered with the City's Community and Economic Development Department (CED), San Diego Association of Governments (SANDAG), San Diego State University (SDSU) and the Regional Economic Development Corporation (EDC) to host the Science and Technology Economic Prosperity Forum (STEP).

The STEP Forum, was designed so that City Council members, CEOs from major science and technology firms, research institutions, trade association leaders, leaders of institutions of higher education, and regional economists could gather to discuss issues important to San Diego's science and technology industries. This event's objectives are to:

1. Provide an opportunity for leading economists to share new information about the positive impact of science and technology industries to the San Diego economy;
2. Discuss opportunities, issues and impediments that impact these industries; and,
3. Facilitate discussion to determine what policy actions local government might take to ensure that science and technology industries continue to thrive in the City of San Diego and the greater San Diego region.

In order to prepare participants for the Forum, SANDAG and CED have collaborated to prepare this STEP Briefing Report on science and technology industry clusters. It is hoped that this Report will inform and prepare Forum participants to engage in productive dialogue about important issues to science and technology firms and institutions.

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EXECUTIVE SUMMARY

The San Diego Science and Technology (SnT) Commission asked SANDAG to develop a briefing report for the STEP Forum that describes traded employment clusters in the San Diego region. Forums such as these are vital for bringing industry, government, and education together to collaborate on key issues essential to economic prosperity. The outcome of these discussions is a greater understanding of our traded employment clusters, providing a fresh look at how local leaders can best address the needs of our Science and Technology businesses. The following is a summary of this report:

Our economic drivers are changing

- It is important to distinguish between those jobs that serve primarily local interests, and those that serve national and international interests. True regional economic development occurs when businesses sell goods and services outside a region and bring in new money that in turn is injected into the regional economy through expenditures on other goods or services or paid out as wages and salaries.
- Historically, manufacturing industries were seen as the key to economic development, exporting their products and serving as the region's "basic industry" or main "driver" of the economy. With an increasingly global marketplace and the rising importance of knowledge and service-based industries, the region's economic engines dispersed into non-manufacturing sectors.

Traded Clusters are the economic engines of the San Diego Economy

- Today, traded employment clusters have replaced the traditional manufacturing sector as the region's driver. All of the Science and Technology Clusters included in this report are traded employment clusters.
- Because they compete nationally and internationally, traded clusters are not constrained by the size of the local market and create opportunity for growth and expansion far beyond the San Diego economy. By competing in the international marketplace, traded cluster firms bring outside dollars into the region and, thus, act as the region's economic engine.

Clusters provide opportunity for a rising standard of living

- Access to an expanded pool of revenue also allows clusters to be high wage generators and offer higher paying employment opportunities. Retaining and expanding these clusters provides the opportunity to improve our standard of living, as measured by per capita income.

The San Diego region has strong potential for cluster growth

- The San Diego region has all the characteristics necessary for cluster success: excellent education and training facilities, world class research institutes, mild climate, coastal location, innovative culture, and skilled labor force. All of these factors help to create synergy between companies and provide the labor and skills necessary for traded clusters to prosper.

- The City of San Diego, in particular is a prime location for traded SnT cluster firms because it contains much of the key infrastructure necessary for successful cluster industries (e.g. higher education and workforce training facilities, international trade infrastructure, etc.). According to SANDAG's most recent estimates, the City of San Diego contains approximately 80 percent of total regional Science and Technology cluster employment. Retaining this employment is an important economic development goal.
- Employment in the SnT cluster industries grew 25 percent between 1995 and 2002, while total employment in the region grew 22 percent. In 2002, the Science and Technology clusters provided over 119,000 jobs, accounting for 28 percent of the region's traded cluster employment in that year (419,700 jobs).
- The number of Science and Technology cluster firms grew more than 67 percent between 1995 and 2002, while the region only grew 10 percent over that same time period.

Cluster wages are increasing

- The average wage rates in the traded SnT clusters range between $49,000 and $92,000 per employee. These wage rates are forty percent to more than one hundred sixty percent above the average wage rate for all jobs in the region ($34,606). The average annual real wages (adjusted for inflation) in all the SnT clusters increased from $57,000 in 1995 to $71,000 in 2002.

The region faces future challenges and opportunities

- Even though we are well-positioned for cluster success, we are not without our share of challenges. Some groups believe that we are increasingly becoming an "hour glass" society, where most jobs are at the top or bottom end of the income distribution and middle income jobs are shrinking.
- Accordingly, one of our most important economic development opportunities is to create middle income jobs and improve our standard of living by encouraging the success of our traded clusters.
- As new jobs in the clusters are created, it is vital that the region provide complementary training so that local residents can take advantage of these employment opportunities.
- Within the City of San Diego, among the most notable challenges faced by cluster businesses today are: preservation of industrial land, radiological waste disposal, reclaimed water usage, and traffic congestion. The City is willing to work closely with cluster companies to address these and any other issues that may hinder their success.

Working to meet the needs of local cluster companies

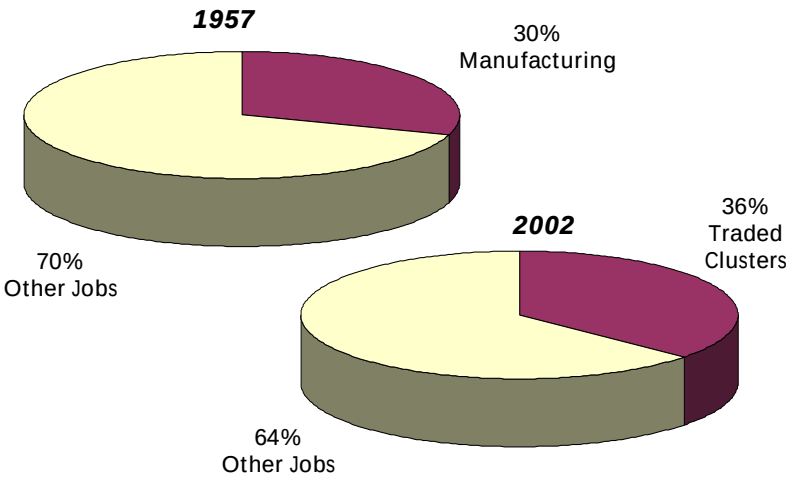
- Research shows that companies do not leave an area because of attraction offers; they leave because they are unhappy with their current location. This suggests that a more successful and efficient economic development strategy is retention, not attraction. Focusing on retention is useful because we already know which companies are here and we can work with them to meet their needs.
- When cluster businesses are ready to expand, the region has a mechanism in place to accommodate them. The City of San Diego has a wide range of programs available. However, these programs should be continually refined to address the most up to date issues faced by our cluster companies.

INTRODUCTION

Have you ever wondered what drives your regional economy? What causes wages and our standard of living to rise? What types of actions can we take to ensure that our economy prospers? It may surprise you to learn that traded employment clusters hold the answer to these and other important questions about our local economy. Today, our economy is restructuring and traded employment clusters are emerging as the engines of economic activity, capable of driving the local economy and providing a rising standard of living. Economic development strategies designed to create and retain jobs in traded clusters provides an opportunity for sustainable economic prosperity.

All industries contribute to the performance of the regional economy. However, it is important to differentiate between those industries that sell their products locally, and those that sell their goods and services outside of the region. True economic development in a region starts when industries bring new money into the region that can in turn either be spent on other goods or services or paid out as salaries. Historically, manufacturing industries were seen as the key to economic development, serving as the region's "basic industry" or main "driver" of the economy. Manufacturing is still important, but is not the only driver of the regional economy. With an increasingly global marketplace and the rising importance of knowledge and service-based industries, there has been a dispersal of the economic engines into non-manufacturing industries. Today, traded clusters have replaced the traditional manufacturing sector as the region's driver. Similar to manufacturing employment in the past, traded cluster employment makes up approximately 30 percent of total regional employment, as shown in Figure 1.

FIGURE 1
OUR ECONOMIC DRIVERS ARE CHANGING



Source: EDD ES202 data, compiled by SANDAG.

The productivity of regional economies depends on the sophistication and efficiency of all of its industries. Nevertheless, it is important to distinguish between industries that primarily serve the local population ("non-traded") and those that sell their products and services nationally or internationally ("traded").[1] These two types of industries have very different roles in economic development. Traded clusters are unconstrained or limited by the size of the local economy because they compete nationally and internationally, leaving opportunity for growth. The drivers are not limited by the size of the local economy and can expand their market far beyond it. By competing in the international marketplace, traded cluster firms bring outside dollars into our region.

Thinking on regional competitiveness is undergoing a transition. Historical efforts to enhance competitiveness were tied to lowering the cost of inputs as regions focused on holding down wages, reducing taxes, and recruiting new companies using financial incentives. This model has been recognized as self-defeating. The true target of economic development is prosperity. Prosperity comes from the ability to utilize a region's inputs more productively than other regions in the creation of goods and services. Low wages do not yield fundamental competitiveness, but they hold down the standard of living. Financial incentives are easily matched by competing regions, and erode the tax base needed to invest in education and local infrastructure.[2]

The role of traded clusters has been addressed by Harvard economist Michael Porter. According to Porter, American businesses are winning in today's marketplace, not by demanding protection in the form of import tariffs, but by constantly innovating – by repeatedly creating and improving products and services, inventing more efficient production systems and technologies, identifying and penetrating new markets, and where appropriate, collaborating both nationally and internationally for mutual benefit.

Clearly, the paradigm that determines "economic development" competitiveness has shifted. The competitive advantage today is driven by the ability of firms to continuously innovate and upgrade. And, innovation is the driving force behind improvements in productivity, a key component of competitiveness in nearly all firms.

In response to this paradigm, the San Diego region is transforming itself by creating a new economy. Today, we're attracting attention as an international model for strategic economic development in traded science and technology clusters. What is the new economy? According to the San Diego Regional Economic Development Corporation, it is a set of fast-moving, knowledge based clusters that will enjoy their strongest growth in the 21st century. It is made up of the kind of companies that every region wants – companies that pay high wages, are internationally oriented, and are engines of sustained growth.[3]

An important characteristic of traded clusters is that they are constantly innovating, sharing workers, and cross-fertilizing; this leads to the formation of new companies. In fact, the number of Science and Technology cluster firms grew more than 67 percent between 1995 and 2002, while the region only

[1] Michael Porter coined the term "traded" and "non-traded" clusters. He emphasized the role of these clusters in his cluster-related work for the Council on Competitiveness. For more information, refer to the Council on Competitiveness' homepage at http://www.compete.org/

[2] "Clusters of Innovation: Regional Foundations of U.S. Competitiveness", Council on Competitiveness, October 2001.

[3] "Partnership for the New Century Economy", San Diego Regional Economic Development Corporation.

grew 10 percent over that time period. Of that total growth in the region, SnT clusters accounted for almost one quarter (approximately 23%).[4]

Within the San Diego region, the City of San Diego is a prime location for traded SnT cluster firms. According to SANDAG's most recent estimates, the City of San Diego contains 80 percent of total regional Science and Technology cluster employment. It also contains a number of the critical pieces of support infrastructure, such as the regional airport and educational and training facilities.

Why have the City and our region been so successful? Our region has all the components necessary for cluster success: excellent education, training and research institutes, mild climate and coastal location, innovative culture, skilled labor force, and some of the country's leading technology clusters. All of these factors create synergy between companies and provide the labor and skills necessary for traded clusters to prosper.

The City of San Diego also has shown commitment to developing strategies that assist local science and technology clusters. In the early 1990's, the City of San Diego's Economic Development Services appointed a 33-member Economic Development Taskforce. Studies commissioned by the taskforce led to the Business and Industry Incentive Policy (CP 900-12) designed to expand manufacturing opportunities and assist emerging science and technology clusters.[5] Also, the City of San Diego was awarded $5.78 million by the US Economic Development Administration to carry out a regional defense adjustment strategy. City, State and federal funds were combined to launch the San Diego Regional Technology Alliance, the World Trade Center-San Diego, the High Technology Resource Center, the Technology Incubator and the Emerging Technologies Seed Capital (EmTek) Fund.

Today, helping businesses in San Diego grow and flourish is a major focus of the City's Economic Development Division. The Business Expansion and Retention (BEAR) team manages the CP 900-12 incentives. The BEAR Team works directly with key businesses to provide advocacy, expedited permitting assistance, tax incentives, and fee reductions to qualified business. According to the City of San Diego, in Fiscal Year 2003 the BEAR Team's assistance resulted in approximately 6,700 jobs being created or retained, $5 million dollars in fee and new tax revenue and in $157 million in new construction projects. Ninety-five percent of the projects receiving assistance were science and technology companies.

Regional Economic Prosperity Strategy: Fostering Cluster Success

Despite these and other efforts, we are not without our share of challenges. Some groups believe that we are increasingly becoming an "hour glass" society, where most jobs are at the top or bottom end of the income distribution and middle income jobs are shrinking. Accordingly, one of our most important economic development challenges is to create middle income jobs and improve our standard of living. This issue is addressed in detail in the San Diego Regional Economic Prosperity Strategy.

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[4] The total number of firms in the region in 1995 was 73,424 and in 2002 was 80,228 (an increase of approximately ten percent over the seven years). The number of SnT firms in 1995 was 2,355, and in 2002 was 3,942 (an increase of 67% between 1995 and 2002). Source: California Employment Development Department, 2004. Cluster definitions and calculations by SANDAG.

[5] Council Policy 900-12, the "Business and Industry Incentive Policy," was aimed at expanding manufacturing opportunities and emerging science and technology clusters. In order to foster industry diversification, CP 900-12 contained economic development incentive assistance for eligible firms, including: permit expediting, advocacy assistance, non-taxable bonding authority as well as fee reduction and rebates (where appropriate). For more information on the services offered by the City of San Diego, please contact the City's Community & Economic Development Department.

The Regional Economic Prosperity Strategy (REPS) recognized the basic restructuring of the region's economy, and developed a set of ten recommended actions designed to create middle income jobs that would ensure a rising standard of living for all San Diego residents. The Strategy's recommended actions are intended to strengthen our existing industries, emerging growth clusters, universities and research and development institutions that together create new enterprises. It also contains recommendations on the roles for business, labor, education and local government to aid in economic diversification. The Strategy's focus is to retain and expand local businesses and create more well paying, high value-added jobs[6] with particular emphasis on the needs of and role played by our traded clusters.

The recommended actions in the REPS are grouped into leadership, people, and infrastructure, suggesting that our leadership and people must be focused and engaged, and our infrastructure investments need to help our companies meet the evolving challenges of the 21st century.[7]

PURPOSE OF THE REPORT

This report has several purposes. First, to clarify the meaning of true economic development and explain the importance of the businesses and jobs that support it; second, to identify leadership opportunities for public and private decision-makers to help achieve the economic development goals in the region; third, to dispel several economic development myths. The report also includes two appendices: a discussion of SnT cluster wage and employment trends since 1995 and a technical appendix describing SANDAG's cluster identification and definition methodology.

This report's analysis covers seven "Science and Technology" (SnT) clusters, as chosen by the Science and Technology Commission, including[8]:

- Biomedical Products
- Biotechnology & Pharmaceuticals
- Communications
- Computer and Electronic Manufacturing
- Defense and Transportation Manufacturing
- Environmental Technology
- Software and Computer Services

IMPORTANCE OF TRADED CLUSTERS TO THE CITY AND REGION

Providing residents and businesses the opportunity to enjoy increased prosperity on a long term, sustainable basis is a regional economic priority and emphasizing the role of traded employment clusters can help a region achieve this goal. This is the basic premise behind a number of local efforts by organizations such as the San Diego Workforce Partnership, Regional Technology Alliance, and Regional Economic Development Corporation (EDC). The EDC's Partnership for a New

[6] Value-added is the difference between the revenue obtained by a firm for a good or service and the cost of the inputs (the labor and materials) used in producing it. For this study we are focusing on clusters for which the labor content is high value-added.
[7] For more information on the Regional Economic Prosperity Strategy, please refer to SANDAG's web site at www.sandag.org. Click on "Economics and Finance."
[8] The cluster definitions used in this report are consistent with the definitions in the SANDAG INFO –"Update: San Diego Regional Employment Clusters – Engines of the Modern Economy", August 2001. For more information refer to SANDAG's Web site at www.sandag.org. For a more in-depth discussion of the cluster methodology, please refer to the Technical Appendix of this report.

Century Economy gathered industry leaders to identify ways to foster the success of some of our region's key traded clusters. The STEP forum is an extension of this effort.

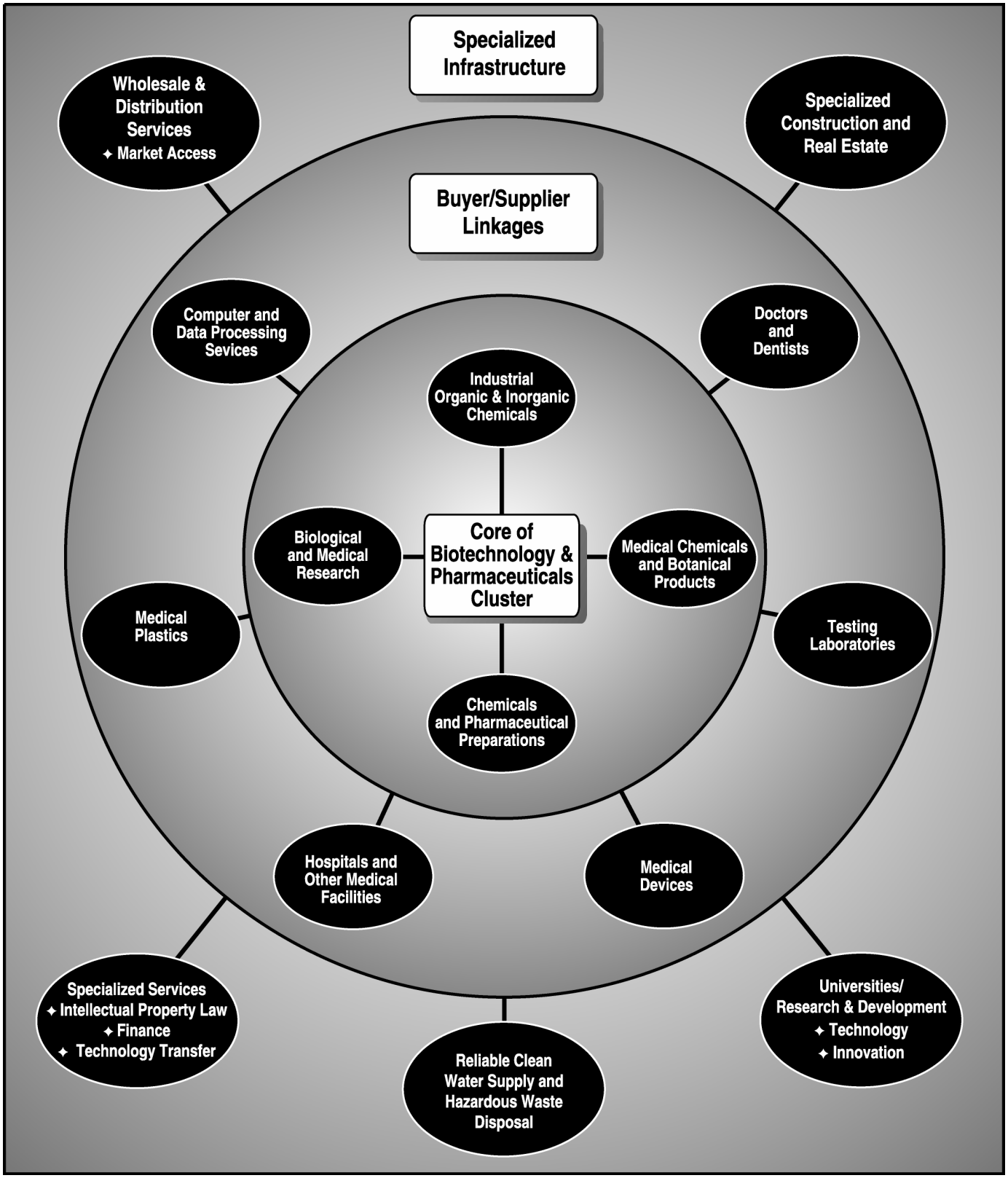
Traded and Non-traded Clusters: Two distinct and important roles

Traded Clusters

Traded clusters are complementary, competing, and interdependent industries that drive wealth creation in the region through the export of goods and services. In addition to exporting, companies in traded clusters exhibit two other distinct characteristics: strong business transaction relationships and close geographic proximity. In traded clusters, transactions between cluster firms are stronger than their transactions with the rest of the economy. Also, by locating close to one another, businesses are able to acquire information, communicate, and share inputs in such a way as to add to a collective and competitive advantage that might not otherwise be achieved alone. Close geographic proximity facilitates collaboration to overcome shared problems and creates synergy between cluster firms. This synergistic collaboration is a defining characteristic of regions with successful traded clusters.

Traded cluster firms require goods and services from local businesses in order to meet the demand for their exports, creating a prosperity multiplier that propels the entire economy. Their employees spend their paychecks at local stores and restaurants, and purchase homes in the area. In the high-tech clusters this effect is exceptionally strong. Without healthy traded clusters, it is unlikely that the rest of our region's economy would prosper.

FIGURE 2
THE BIOTECHNOLOGY & PHARMACEUTICALS CLUSTER
A Single Cluster's Relationship with the Regional Economy

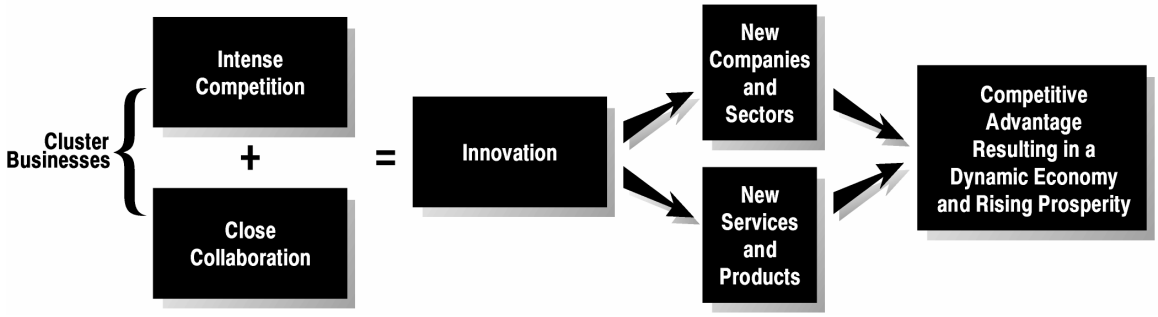


Traded clusters are connected to the entire economy. At the heart of a traded cluster is a group of core, exporting sectors. Surrounding the core are various buyers and suppliers that are closely linked to and directly interact with the cluster. Supporting the whole operation is a reliable and sustainable physical and human infrastructure.

Figure 2 is a diagram of the Biotechnology and Pharmaceuticals cluster. The core of the "Biotech" cluster consists of various interrelated chemical manufacturers, biological research facilities, and other service providers. The next ring illustrates the linkages between the primary buyers and suppliers to the cluster's core. These sectors are essential for the cluster's production process but are not part of the core or included in the cluster's definition. The outer ring shows that clusters rely on a diverse foundation of specialized infrastructure, such as a reliable water supply, hazardous waste disposal, and top quality university research.

Traded clusters are also a fertile ground for new business creation. As they mature, cluster firms create demand for new types of products and services, some of which can be supplied by existing firms (such as a local biotechnology firm developing a vaccination useful for a defense firm involved in anti-terrorist technology). Some clusters generate demand that encourages the creation of new local firms. In short, the cluster dynamic gives companies and their regions a competitive leg-up against other regions. As shown in Figure 3, cluster businesses create competition and collaboration. This spurs innovation, which leads to new companies and new products and services. The products give the region a competitive advantage over others. The end result is a higher influx of capital and a rising economic profit.

FIGURE 3
CLUSTERS PROVIDE A COMPETITIVE ADVANTAGE FOR THE SAN DIEGO REGION



Fresh ideas from research institutions, often in the form of technology transfers, also lead to the creation of new businesses. Many people are aware of how the Communications cluster grew out of UCSD in the 1960s. The initial seed was planted with Linkabit, which led to the creation of Sciquest and Comstream. Out of this arena emerged Qualcomm. As Qualcomm began to develop into one of the world's leading communication firms, numerous other companies, such as PCSI, Tiernan, and CommQuest opened their doors in the region. Once the foundation of the Communications cluster was established and a critical mass of companies developed in the region, San Diego served as a breeding ground for further entrepreneurial activity and attracted companies and talent from other locations. Today, the San Diego region's Communications cluster is one of the most successful in the country. For a visual depiction of the evolution of the Communications and Biotechnology and

Pharmaceutical clusters, please refer to the section titled: "Descriptions of traded science and technology clusters in the San Diego region."

Non-traded Clusters

Non-traded clusters are also inter-related and geographically concentrated, but do not export their goods or services the way that traded clusters do. Although not primary economic drivers, non-traded clusters provide economic stability and a diverse range of jobs. For example, the construction industry supplies a significant number of jobs and is responsible for the region's infrastructure and housing, but does not typically export its service outside of the area.

Another example of non-traded clusters' economic importance is seen in education. Though the educational system is not considered a traded cluster, it provides critical support and necessary infrastructure for regional prosperity. A rigorous K-12 school system is important for providing the fundamental skills required of today's entry-level labor pool. High-technology, knowledge-based clusters such as those identified by the Science and Technology Commission are extremely dependent on local universities for skilled workers, international contacts, and new innovations. Community colleges provide important training and retraining, as well as the opportunity to bridge the gap between high school and four-year colleges.

History of Clusters: From Italy to San Diego

While many people have only recently become aware of employment clusters, the worldwide academic community has discussed cluster analysis and theory for many years.[9] In fact, the regional benefits of clusters as we discuss them today were first identified in the Emilio Romano region of Italy. In the 1990s, Harvard Economist Michael Porter popularized the role of clusters in economic development at a national level in his book, "The Comparative Advantage of Nations." (New York: Basic Books, 1990)

Clusters were introduced as an economic development tool locally in 1994 in an effort to aid in the economic recovery of a San Diego region still reeling from defense downsizing and the recession of the early 1990s.[10] As a result of the recession, the region experienced a significant loss of high-paying, high value-added jobs. A strategy was needed to combat the negative effects of the lengthy economic downturn. Collaborative Economics and a local group of advisors helped identify employment clusters that would serve as the foundation from which the San Diego region could regain some of the high value-added jobs that were lost during the recession.

SANDAG has improved upon the initial cluster work by creating a replicable, methodology that determines a more precise definition of the region's clusters. Today's clusters focus on concentration, transactions, value-added inter-relationships and the geographic location of industries. Clusters are a descriptive and comprehensive tool to inform policy decisions and allocation of resources.

[9] The theory that groupings of similar and inter-related industries generate positive benefits and provide competitive advantages originated in Italy and has been in circulation since the 1950s. Over the last 15 years, the use of clusters as a regional economic development tool has become increasingly more accepted and utilized here in the United States.
[10] Collaborative Economics, "San Diego Economic Opportunities Overview", (1995).

In fact, supporting the health of regional employment clusters is a focus for economic development efforts around the region. A diverse range of organizations has collaborated to foster infrastructure investment and develop policy on a number of fronts. These organizations also provide a support network and a voice for regional businesses on a complex range of issues far beyond clusters. Examples of these organizations include: UCSD Connect, San Diego Regional Chamber of Commerce, regional and sub-regional Economic Development Corporations, the World Trade Center, San Diego Regional Technology Alliance, Industry Trade Associations, San Diego Unified Port District, and many more around the region. Lastly, the California Employment Development Department and the State's Workforce Investment Board have funded studies to identify California's major cluster locations.

Traded Science and Technology Cluster Employment

In 2002, the Science and Technology clusters provided over 119,000 jobs, accounting for twenty-eight percent of the region's traded cluster employment in that year (419,700 jobs).[11] Employment in the SnT cluster industries grew by twenty-five percent between 1995 and 2002, while total employment in the region grew by twenty-two percent. Recessionary trends in the national economy may have contributed to a decline in certain SnT cluster employment in recent years. However, despite these trends several clusters showed strong signs of growth over the seven year time period. Since 1995, the number of residents employed in our Software and Computer Services cluster has doubled, and the number of new jobs created in our Communications, Environmental Technology, and Software and Computer Services clusters have increased more than forty percent (see Table 1).

TABLE 1
SCIENCE AND TECHNOLOGY CLUSTER EMPLOYMENT TOTALS

	1995	1996	1997	1998	1999	2000	2001	2002
Biomedical Products	6,559	6,431	6,135	5,765	6,444	6,256	7,098	6,368
Biotechnology and Pharm.	17,235	18,629	20,371	23,008	21,385	23,056	23,341	24,159
Communications	14,789	16,422	18,174	20,646	25,771	24,878	22,073	21,162
Computer & Electronics Mfg.	20,303	21,679	22,990	25,058	23,734	24,169	20,915	18,843
Defense Mfg.	20,466	18,953	19,578	19,113	19,559	18,149	17,215	18,066
Environmental Technology	3,356	4,154	4,280	4,469	4,627	4,580	5,925	5,765
Software and Computer Serv.	12,367	13,645	15,453	17,660	18,363	21,290	24,803	24,755
SnT Cluster Totals	***95,075***	***99,913***	***106,982***	***115,719***	***119,883***	***122,378***	***121,370***	***119,118***
Total Regional Employment	***1,155,300***	***1,175,900***	***1,230,800***	***1,274,600***	***1,319,600***	***1,351,800***	***1,383,000***	***1,405,300***

Notes: 2001 and 2002 data use NAICS classification codes, 1995-2000 use SIC codes. The bridge between SIC and NAICS codes may explain some volatility.
Source: EDD ES 202 data, compiled by SANDAG using 2000 SANDAG cluster definitions. These are preliminary employment estimates and will be updated in 2004.

[11] Employment and wage estimates in this report are preliminary and will be finalized by SANDAG in 2004. The definitions are based on the new North American Industry Classification System (NAICS) coding scheme. To date, clusters have been presented under the Standard Industry Classification (SIC) codes. To update the definitions, a "bridge" was applied. The transition from SIC to NAICS data in 2001 explains some of the fluctuations in the data. The definitions used for this report will be refined from the initial bridge estimates, but the current numbers serve as a valid approximation of regional trends.

Traded Science and Technology Cluster Wages

Because traded clusters access the global marketplace, they bring new money into our region. This access to an expanded pool of revenue allows clusters to be high wage generators (up to 160% higher than the regional average) and thus provide higher paying employment opportunities. As shown in Table 2, Science and Technology clusters pay wages significantly higher than the regional average. The average wage rates in the SnT clusters range between $49,000 and $92,000 per employee. These wage rates are forty percent to more than one hundred sixty percent above the average wage rate for all jobs in the region ($34,606). Real wages (adjusted for inflation) in these clusters increased during the 1995 to 2002 time period from $57,000 to $71,000. The Communications, Software and Computer Services, and Computer and Electronics Manufacturing clusters pay the highest average wages of the Science and Technology clusters.

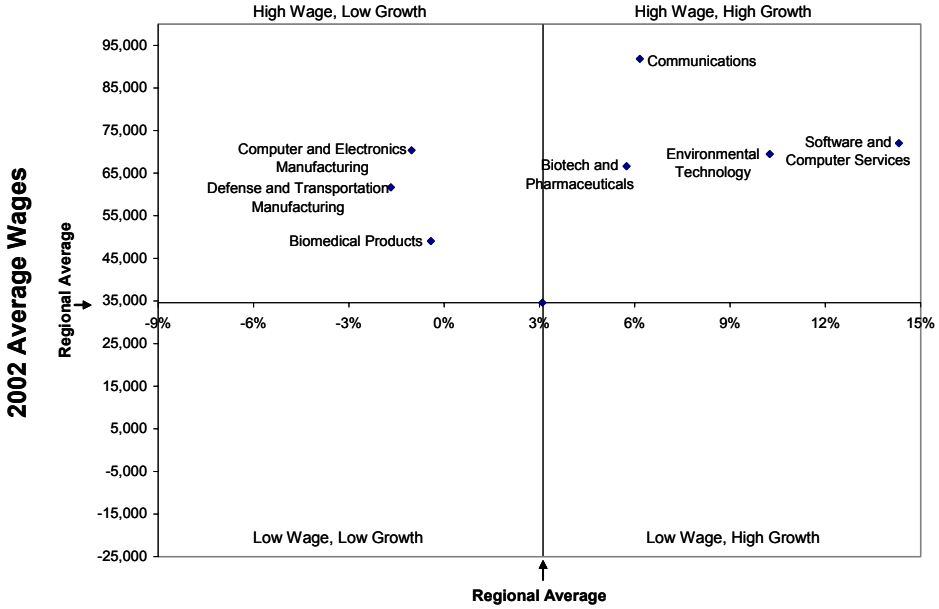
TABLE 2
SCIENCE AND TECHNOLOGY CLUSTER WAGE RATES (2002 DOLLARS)

	1995	1996	1997	1998	1999	2000	2001	2002
Biomedical Products	$ 48,388	$ 48,560	$ 49,029	$ 49,243	$ 46,790	$ 50,045	$ 47,506	$ 49,073
Biotechnology and Pharm.	58,276	61,812	66,766	66,341	68,944	76,062	68,968	66,601
Communications	59,902	59,588	59,567	60,895	121,735	125,908	97,309	91,809
Computer & Electronics Mfg.	56,074	61,448	63,730	64,118	70,638	78,614	73,112	70,375
Defense Mfg.	54,183	52,304	56,417	62,325	58,349	57,498	61,012	61,669
Environmental Technology	47,716	47,680	49,924	51,204	50,058	49,181	64,159	69,460
Software and Computer Serv.	65,140	64,998	68,922	75,641	80,176	85,915	77,219	72,050
SnT Cluster Wages	***$ 57,016***	***$ 58,558***	***$ 61,617***	***$ 64,208***	***$ 78,700***	***$ 83,324***	***$ 73,904***	***$ 71,262***
Regional Wages	***$ 26,353***	***$ 27,001***	***$ 32,075***	***$ 34,213***	***$ 34,877***	***$ 36,058***	***$ 35,077***	***$ 34,606***

Notes: 2001 and 2002 data use NAICS classification codes, 1995-2000 use SIC codes. The bridge between SIC and NAICS codes may explain some volatility.
Source: EDD ES 202 data, compiled by SANDAG using 2000 SANDAG cluster definitions. These are preliminary wage estimates and will be updated by SANDAG in 2004.

Though average wages are higher in all of the Science and Technology clusters than in the region, employment growth varies relative to the rest of the economy (see Figure 4). Over the seven year period, three clusters exhibit slightly negative average annual employment growth, below the regional average. The other four SnT clusters experienced high employment growth combined with high wages. The fastest growing clusters were Environmental Technology and Software and Computer Services, both with growth rates over ten percent. Clusters with high wages and high growth can be classified as emerging clusters.

FIGURE 4
SnT TRADED CLUSTERS WAGE AND EMPLOYMENT GROWTH



Source: 2002 EDD ES 202 data, complied by SANDAG using 2000 cluster definitions.

TRADED SCIENCE AND TECHNOLOGY CLUSTERS IN THE CITY OF SAN DIEGO

Clusters are a regional phenomenon, requiring a regional labor pool and infrastructure network (airports, water ports, etc.). However, the location of cluster firms is specific to a local jurisdiction. Of all the local jurisdictions in the region, the City of San Diego contains a majority of employment in each of the region's science and technology clusters.

According to the most recent estimates, the City of San Diego contains 80 percent of total Science and Technology cluster employment, including 75 percent or more of the following clusters: Biotechnology and Pharmaceuticals; Communications; Computer and Electronics Manufacturing; and Software and Computer Services (see Table 3). The City of San Diego is also important because it contains a significant portion of the support infrastructure necessary for the success of the region's clusters, including access to international markets, several colleges and universities, and numerous workforce development and training facilities.

TABLE 3
CITY OF SAN DIEGO
SHARE OF REGIONAL SCIENCE AND TECHNOLOGY (SnT)
CLUSTER EMPLOYMENT

	City Share
Biomedical Products	50%
Biotechnology and Pharmaceuticals	86%
Communications	90%
Computer & Electronics Manufacturing	84%
Defense & Transportation Manufacturing	69%
Environmental Technology	58%
Software and Computer Services	81%
Total Share of Regional SnT Employment	**80%**

Source: California EDD, ES 202 data files, 2000

As shown on the following page, not only does the City have a significant amount of cluster employment, each Council District also includes some amount of SnT cluster employment. The map in Figure 5 shows the percent of SnT traded cluster employment by City Council District. The pie chart represents the distribution of cluster employment in each Council District. For example, District Five contains employment in each cluster category which together represents 40 percent of all SnT cluster employment within the City. The Communications cluster makes up much of the SnT employment in Districts 3 and 4, while Biotech employment is the dominant cluster in Districts 1 and 7. Districts with access to the water and Port infrastructure (Districts 2 and 8) have higher concentrations of Defense and Transportation Manufacturing cluster employment.

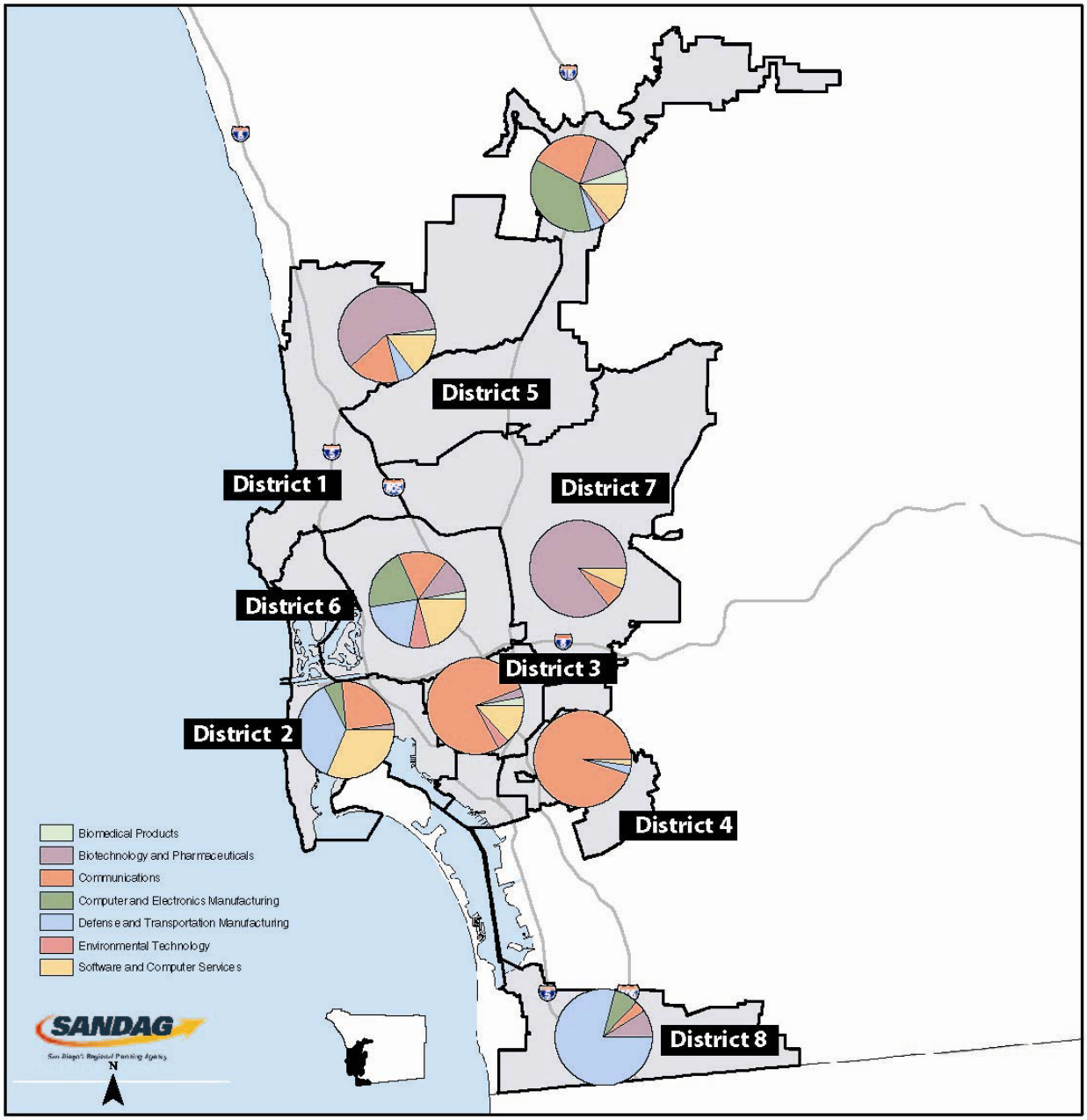
CLUSTER DYNAMISM AND OUTLOOK

Clusters are constantly evolving and re-inventing themselves. Clusters have a life cycle that begins with small, emerging growth companies that prosper as they mature. Over time, the older companies may eventually begin to decline by either fading away or moving in a new direction. To maintain an accurate understanding of the region's driving industries; SANDAG regularly updates and monitors the composition of the employment clusters. While the majority of the cluster relationships and definitions remain stable, over time the groupings evolve.

Emerging Clusters

Clusters relationships change over time. The result may alter a cluster's composition, such as the addition of Optical Products to the Biomedical Products cluster; or result in entirely new clusters emerging, such as the Communications cluster in the 1960s. Emerging clusters are groups of relatively small, inter-related industries that have initially experienced high rates of growth, such as the Environmental Technology cluster in the San Diego region. Intense competition and close cooperation spur innovation across industries, often spawning the development of entirely new companies and industries. These emerging clusters may be more sensitive to market conditions and policy actions and are therefore a useful target for economic development efforts.

FIGURE 5
SCIENCE AND TECHNOLOGY TRADED CLUSTER EMPLOYMENT BY COUNCIL DISTRICT
PERCENT OF TOTAL IN EACH COUNCIL DISTRICT



PERCENTAGE OF TRADED CLUSTER EMPLOYMENT BY COUNCIL DISTRICT

Council District	1	2	3	4	5	6	7	8
Biomedical Products	1.9	.09	3	0	5	3	1	0
Biotechnology and Pharm.	58	2	3	0	14	12	85	9
Communications	17	24	76	95	23	17	7	4
Computer and Electronics Manf.	0	6	.46	0	37	21	.10	8.3
Defense and Transportation Manf.	6	36	0	3	5	20	.10	79
Environmental Technology	1	.05	5	0	2	7	0	0
Software and Computers Services	15	31	13	2	14	21	7	.65
% Total City SnT Employment	**25**	**5**	**1**	**.30**	**40**	**21**	**2**	**7**

Source: SANDAG 2000 Employment Inventory.
Totals may not equal 100 due to rounding.

LOCAL POLICY ISSUES RELATED TO SCIENCE AND TECHNOLOGY FIRMS

A number of local policy issues are important to Science and Technology clusters in the San Diego region; forums such as these provide us with an opportunity to identify and comment on key issues. The City of San Diego has identified four issues related to SnT clusters: preservation of industrial land, radiological waste disposal, reclaimed water usage, and traffic congestion. The following is a brief overview of these economic development concerns, including a description of the problem, and any action or advocacy efforts underway.

Preservation of Industrial Land for Clusters

The conversion of industrial land into residential land, together with proposed "co-location" of residential uses onto industrial parcels, pose a challenge to science and technology firms, and have provoked a considerable amount of debate. For-profit science and technology firms are classified for land use purposes by the City as "industrial."[12] These firms are typically engaged in light manufacturing as well as research and development (R&D) and often locate in an industrial base zone. Industrial zones encourage collaboration across firms and foster cluster synergy.

Most industrial base zones allow other types of firms to locate within their boundaries, despite potential incompatibility. Commercial uses, such as offices and retail stores, as well as institutional uses such as schools and churches, are located in many industrial areas. While co-locating or "mixing uses" can provide a number of benefits such as reduced transportation congestion and commute times, the encroachment of these non-industrial uses primarily causes two problems for the existing firms:

1. Operational constraints for the industrial user.
2. Competition from non-industrial firms for the same land and buildings.

Operational constraints resulting from land use incompatibility can include increased regulatory compliance costs, restricted hours of operation, and lawsuits, all of which divert resources from productive activities.

Although most technology firms have continued to express concern over the rising cost of housing, many see this proposed solution as creating an even greater problem. Technology firms that use hazardous chemicals, require diesel trucks, or produce radioactive wastes are especially concerned that non-industrial residents could use political and legal pressure to prevent business expansion or otherwise curtail operations. Understandably, firms are therefore concerned about conversion and co-location proposals.

A secondary concern relates to rising occupancy costs that stem from land-use competition within industrial parks. Competition for space occurs across all economic sectors, and is one cost of doing business. However, due to the scarcity of industrial employment land, it is particularly acute for firms classified as "industrial." Competition for land affects all high-technology firms, but most negatively affects light manufacturers, who face shrinking profit margins, and biotechnology firms that are still in

[12] The "industrial" classification stems from the restriction of R&D activities in residential zones, along with practical considerations that discourage high-tech firms from locating in commercial zones.

the R&D phase of the production process and therefore have not yet achieved profitability. These concerns are described in detail in the City's Progress Guide and General Plan.

Radiological Waste Disposal

BIOCOM, the region's biotechnology trade organization, and UCSD Connect, a high-tech/bio-tech educational and advocacy organization, have continued to emphasize the need for a permanent solution to the rising costs associated with disposal of low-level radioactive waste (LLRW). This type of waste can be a product of the biotechnology research process, but can also come from other technology firms, as well as clinics and hospitals. The only solution to date, the opening of a LLRW dump site in Ward Valley, has been put on hold indefinitely due to opposition from environmental groups. Thus, for the foreseeable future, LLRW is generally stored in on-site containment structures within the City's many high-tech industrial parks. It is the presence of these potentially dangerous structures that may drive opposition to residential conversion and co-location proposals in communities throughout the region.

Reclaimed Water Usage

Another concern expressed by Science and Technology firms is the water rationing that could take place in the event of a drought. This is especially critical for firms that use large amounts of water in clean rooms and "wet labs" for cooling and industrial processing, or are involved in "wet process" manufacturing. Mandatory conservation measures or substantial commodity price increases would negatively impact profitability and scientific achievement for these firms. The City has installed a network of reclaimed water pipes in the Golden Triangle area that connect to its North City Water Reclamation Facility. It has also created a Guaranteed Water for Industry Program, which grants industrial businesses exemptions from conservation measures, provided they utilize reclaimed water to the greatest extent possible, while employing voluntary potable water conservation methods. Unfortunately, only four businesses have taken advantage of this program to date, although several others are now taking steps toward implementation.

Concerns are chiefly tied to the effect of scaling in cooling towers, combined with regulatory hurdles and "inconveniences" imposed by City, County and State agencies. For its part, the City has failed to expand the optimized zone for the reclaimed water distribution system into many high-tech industrial areas. Despite these issues, the use of reclaimed water provides firms with substantial long-term savings over the long term due to discounted rates. To the greatest extent possible, the City of San Diego will continue to improve the availability of this resource and work with local firms to offer incentives for linking to the system.

Traffic Congestion

While traffic congestion is a "hot button" issue throughout southern California, it is especially problematic in the high-tech communities of northern San Diego. The notorious "merge" at the junction of the I-5 and I-805 freeways is just one example. Portions of the I-15, beginning at Scripps Ranch and continuing through Rancho Bernardo, are similarly impacted. Many local collector and arterial roads that connect industrial parks with major freeways are also heavily congested.

As a general rule, funding for transportation infrastructure throughout California has not kept pace with population growth, and San Diego is no exception. Budget constraints at all levels of government portend serious problems in this area with no apparent relief in site. Solutions must come from the local level and will, by necessity, require innovative solutions based substantially on the involvement of the business community.

In northern San Diego communities, science and technology firms will be called upon to lead the way through action, advocacy, and partnership with governmental and quasi-governmental agencies. This problem will need to be addressed comprehensively by evaluating, selecting, and implementing strategies that both increase system capacity while reducing demand, or at least reducing the rate of increase in demand.

Action – Technology firms and scientific research institutions can take action by encouraging ridesharing, use of transit, telecommuting, and the adoption of flexible work schedules. Many firms have already implemented systems and incentives incorporating some or all of these measures. Traffic congestion would be worse but for the actions of these firms and their employees. However, participation in Transportation Demand Management (TDM) programs must be voluntary. Partial experimentation with mandatory TDM programs has been met with considerable resistance. They don't work for all firms and all employees.

Advocacy – Technology firms and scientific research institutions can advocate changing the way transportation funds are sourced and utilized. Extension of the TransNet district sales and use tax measure and the allocation of its revenue to various projects are the most obvious examples. High-tech employers have direct access to almost 100,000 employees and could help local governments inform these voters on transportation issues.

Firms could also advocate for land use changes, which would reduce traffic in the northern technology communities. For example, many non-technology office firms locate in the northern industrial parks either because senior management lives in a northern residential community, or because industrial land and buildings are available at prices substantially lower than traditional office markets such as downtown, mid-city, and Mission Valley. Empirical and anecdotal evidence indicates that technology employees live primarily in these northern residential areas, while office employees are geographically dispersed throughout the county. This phenomenon suggests that incentives and land use policies should be used to strongly encourage office firms to locate centrally, shortening the commute for many of their employees.

Partnership – Technology firms and scientific research institutions can partner with governmental and quasi-governmental agencies by responding to initiatives and programs put forth by the City, County, and SANDAG. Such programs include TransNet, the City's General Plan update, and SANDAG's Mobility 2030 Plan. These partnering activities are largely part of the Action and Advocacy sections discussed above, but can be extended to include corporate contributions for congestion relief such as company-sponsored vanpools that collect employees from government-funded transit stops and shuttle them to industrial parks. Some technology firms have also agreed to mitigate the traffic impacts associated with their own new building projects by funding off-site improvements to nearby collector streets.

DISPELLING ECONOMIC DEVELOPMENT MYTHS

There are a number of economic development "myths" that should be addressed since they are directly related to the importance of clusters and because policy actions are often developed in response to these myths. Each of the following myths is related, and reinforces the value of a strategic approach for public policy and infrastructure investments that encourage traded cluster success.

Myth: The more sales tax revenue, the higher a city's standard of living

A common myth is that a city can improve its residents' standard of living by increasing sales tax revenue, and therefore, increasing the municipal budget. Since the passage of Proposition 13, local jurisdictions have little control over locally generated property tax revenues, receiving approximately 17 percent of the tax revenue generated.[13] Local governments often find it difficult to fund basic public services and facilities and have been forced to look elsewhere for resources. One stable source of revenue on which local governments have become increasingly reliant is sales tax. Sales tax revenue represents a source of funds that can help raise revenue for the municipal budget; however, there are negative consequences for jurisdictions that chase retail outlets in order to create revenues.

By attracting retail establishments, jurisdictions guarantee themselves sales tax revenues. However, the majority of jobs they develop with this approach do not raise the jurisdiction's or region's standard of living. Retail employees earn a lower than average wage and often do not enjoy benefits such as employer sponsored healthcare or paid time off. Low wage industries may require additional levels of social services and spending from the public sector, and typically generate smaller economic impacts, fueling less money back into the regional economy than higher paying industries. Investing in these low value-added businesses creates an economy that lacks a robust mechanism for growth and prosperity. High value added employment contributes more to the region's standard of living and should be a focal point for economic development efforts.

Myth: In economic development all jobs are equal, "a job is a job"

Another myth is that all jobs are the same. It is true that the productivity of all regional economies depends on the sophistication and efficiency of all of its jobs and that all jobs contribute to determining the output per worker of the economy. However, it is important to distinguish between those jobs that primarily serve local interests, and those that serve national and international interests. True regional economic development occurs when businesses sell goods and services outside a region and bring in new money that in turn is injected into the regional economy through expenditures on other goods or services or paid out as wages and salaries. The worker who earns the salary often spends it by patronizing local businesses, and continues the successive chain of impacts. This is what occurs when economic drivers, or traded clusters, flourish. This multiplier effect is what ultimately fuels economic prosperity.

This point can be illustrated using retail as an example. Retail employment and business activity are a necessary part of the regional economy; however, it is not from retail that we obtain a rising

[13] Proposition 13 capped property taxes, a major source of revenue for cities, at 1% of assessed valuation. The City of San Diego receives approximately 17% of the property tax revenue collected within its jurisdiction. In Fiscal Year 2004, property tax receipts accounted for 27% of the City's general fund budget.

standard of living. Most retail establishments sell goods to the local population, and are not responsible for bringing new money to the region. Retail activity is what results after "economic development" has already occurred and given residents a higher wage and greater disposable incomes. New retail establishments open in a region only after it has been shown that the local population can sustain their trade. The location of retail outlets is only important because of the way we distribute sales tax revenue.[14] If residents do not have the means to purchase from auto dealerships and big-box retail outlets, the stores do not profit and will quickly close their doors.

Myth: Cities must offer financial incentives or other giveaways to keep or attract good jobs

Many regions believe that offering significant financial incentives and other business subsidies is the only way to attract companies, and go to great lengths to outdo other areas. Belief in this myth can result in a race to the bottom, where regions are caught in a downward spiral of offering more and more to a company in hopes of winning the company's location decision. Encouraging companies to locate in the region by sacrificing fees and tax revenue does not provide sufficient funding for the costs associated with the additional infrastructure and services required to serve these businesses. Essentially, by competing in this way, a region becomes LESS attractive and often sacrifices the advantage that helped make its economy successful in the first place. While some companies may value incentives, luring these companies with tax incentives can erode the region's fiscal health.

Research shows that companies do not leave an area because of attraction offers; they leave because they are unhappy with their current location. This suggests that a more successful and efficient economic development strategy is retention, not attraction. Focusing on retention is useful because we already know which companies are here and we can work with them to meet their needs.

Research also shows that one of the most important factors for retaining knowledge-based industries (such as those in the Science and Technology clusters) is a skilled labor force. This is supported by site selection surveys, which typically indicate that labor factors (availability, productivity) are the most important criteria when screening locations. If we want to be a successful region we need a highly skilled and educated workforce. Focusing on the needs of the labor force is the best way to retain talented workers, as emphasized in the San Diego Workforce Partnership's "Path to Prosperity" report.[15]

It is important to note that some policy actions that may also be considered "incentives", such as permit expediting, can be very useful to local jurisdictions as business retention tools. This form of incentive represents assistance to local cluster firms and encourages economic growth from within the region. The role of these retention incentives is to improve the region's business climate, address cluster needs, and help local government keep track of what San Diego companies require to be successful. These are not large financial incentives that harm the fiscal health of a municipality or jeopardize its ability to provide important infrastructure and services.

Examples of retention incentives that contribute to traded cluster economic development include: business advocacy, expedited permitting assistance, and, in certain circumstances, fee reductions.

[14] Recently, the City of Santee agreed to pay the developer of the new Trolley Square Mall 75 percent of the sales tax revenue generated from the project for the first seven years. The first year of mall operations generated $600,000 in sales tax revenue, a good portion of which was forfeited by the City. This money could have contributed to addressing the infrastructure or other needs.
Source: "Santee mall's sales taxes exceed $600,000." By Jose Luis Jimenez, San Diego Union Tribune, San Diego Section "East" page B1, March 10, 2004.

[15] "A Path to Prosperity: Preparing our Workforce." San Diego Workforce Partnership, December, 2002.

These incentives can be used to encourage participation in programs that are beneficial to the City and region. For example, encouraging enrollment in water recycling, workforce training, and energy conservation programs is appropriate because it provides benefits to a broad range of residents and typically requires a matching contribution from the company.

CONCLUSION

Healthy employment clusters are an important component of a sustainable, prosperous economy. For these reasons, it is vital that clusters flourish within the San Diego region. As a region, support from the public and private sectors will provide an environment conducive to cluster health and growth and contribute to a higher standard of living.

Prosperity comes from the ability to utilize a region's inputs more productively than other regions in the creation of goods and services. Low wages do not yield fundamental competitiveness; rather they hold down the standard of living. American businesses are winning in today's marketplace, not by demanding protection in the form of import tariffs, but by constantly innovating – by repeatedly creating and improving products and services, inventing more efficient production systems and technologies, identifying and penetrating new markets, and where appropriate, collaborating both nationally and internationally for mutual benefit.

Clearly, the paradigm that determines "economic development" competitiveness has shifted. The competitive advantage today is driven by the ability of firms to continuously innovate and upgrade. And, innovation is the driving force behind improvements in productivity, a key component of competitiveness in nearly all firms. Encouraging the success of our regional traded employment clusters and addressing their needs is a key to creating prosperity.

APPENDIX 1: DESCRIPTIONS OF TRADED SCIENCE AND TECHNOLOGY CLUSTERS IN THE SAN DIEGO REGION

Note: *For the percentage change in employment and real wages discussed in this section, the data have been indexed to a 1995 base year. Lines in the graph represent the annual rate of change from the base year.*

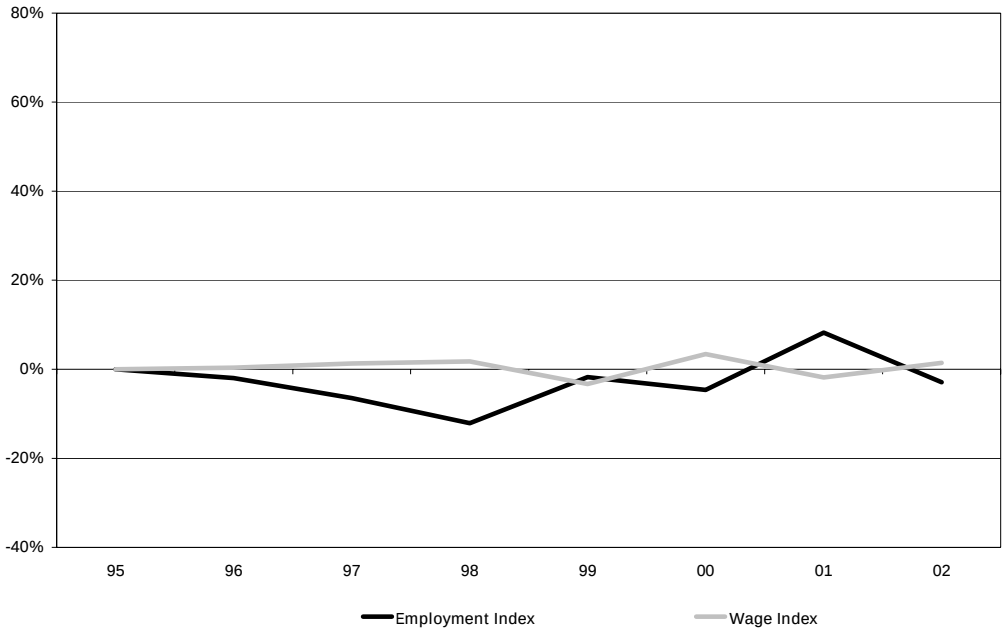
Biomedical Products

The San Diego region's Biomedical Products cluster produces instruments, medical devices, equipment and other apparatus primarily for consumption by the medical field. Examples of this cluster's products include X-ray machines, surgical knives, and contact lenses. Biomedical products have a wide range of uses such as delivering pharmaceuticals, monitoring patients, providing therapy, and serving as artificial human organs. The Biomedical Products cluster is knowledge-intensive, requiring advanced research and development. Also, the cluster is often combined with the Biotechnology and Pharmaceuticals cluster and referred to as a "Bio-Sciences" cluster.

As shown in Figure 6, real wages and employment in the Biomedical Products cluster remained fairly stable from 1995 to 2002. In 2002, real wages in this cluster show a one percent increase since 1995, while employment shows a decrease of three percent. One reason for a decline in biomedical product employment might be the increasing amount of biomedical product firms locating in neighboring Riverside County and in Mexico. This provides an opportunity for cross-border and inter-regional collaboration. Employment in the "Bio-Sciences" cluster has grown steadily between 1995 and 2002, increasing twenty-eight percent to more than 30,500 jobs in 2002.

FIGURE 6
BIOMEDICAL PRODUCTS

Percentage Change in Employment and Wages*

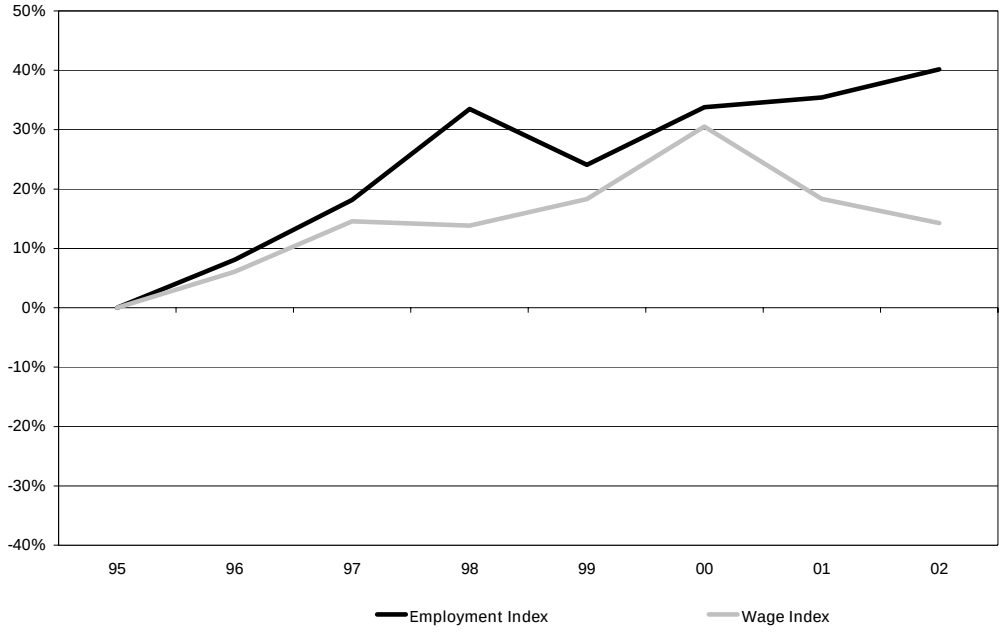


Biotechnology and Pharmaceuticals

The Biotechnology and Pharmaceuticals cluster includes sectors engaged in researching, manufacturing, or processing a broad range of biological, chemical, and medicinal products. Medical and industrial chemicals and preparations are also included in this grouping. The cluster does not include instrument or equipment production. Examples of products include antibiotics, bacterial vaccines, and biological research and development. "Biotechnology is an umbrella term for research and product development activities that use organisms or their cellular components to find new therapeutic and diagnostic medical tools."[16] The rise of San Diego's biotech sector is often credited to the local presence of major research institutions, such as the University of California at San Diego Medical School, the Scripps Research Institute, the Salk Institute for Biological Studies, and the Burnham Institute. The success of Hybritech, founded in 1978 and often regarded as the forefather of today's biotech cluster, was directly related to the presence of these institutes. Hybritech was the vehicle though which large pharmaceutical firms noticed San Diego, after Eli Lilly and Company purchased Hybritech in 1986. Former Hybritech employees have gone on to found several dozen biotechnology companies in the San Diego region, as shown in Figure X. The Biotechnology and Pharmaceuticals cluster is often combined with the Biomedical Products cluster and referred to as a "Bio-Sciences" cluster.

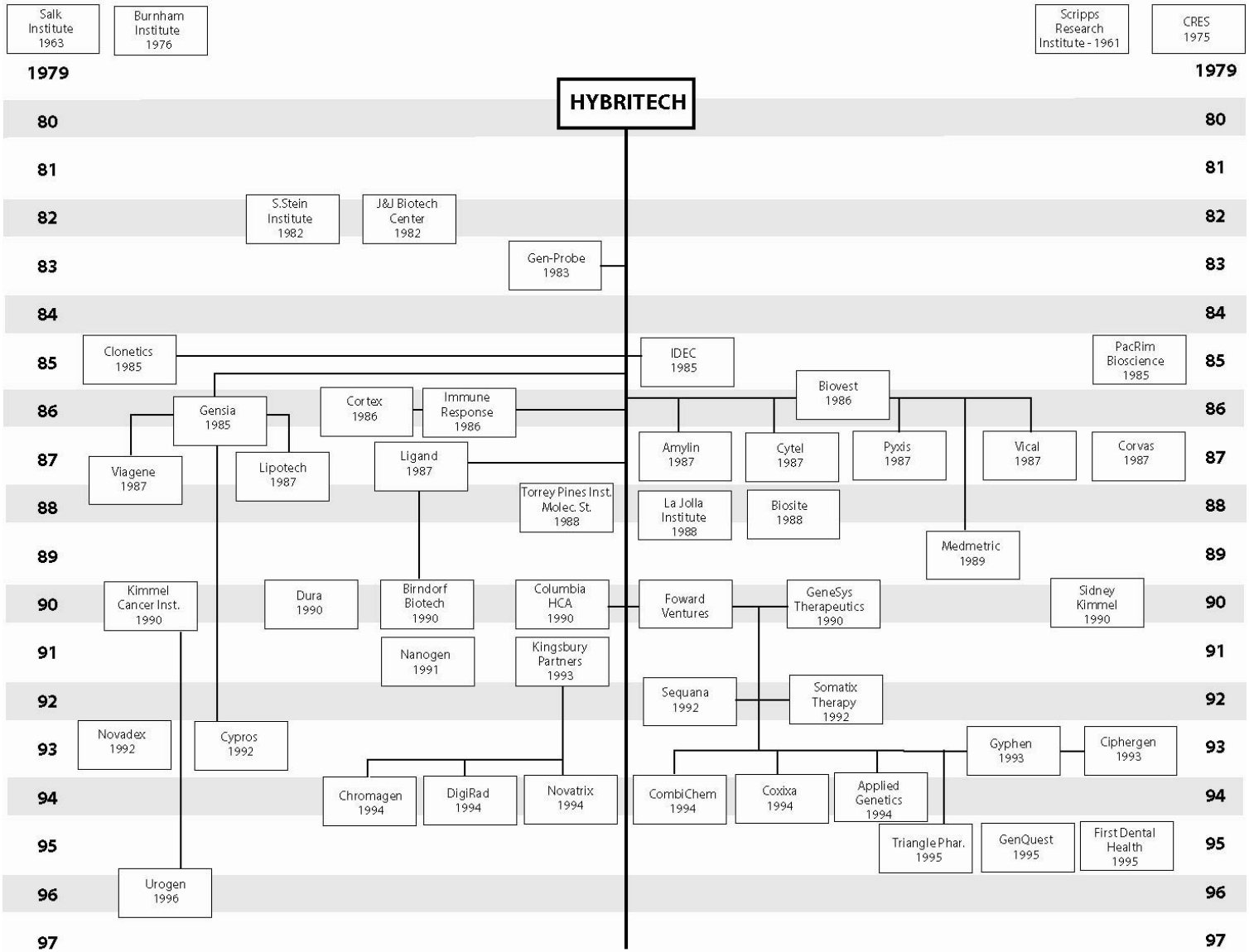
As shown in Figure 7, employment and real wages within the Biotechnology and Pharmaceuticals cluster have increased overall between 1995 and 2002 with employment increasing forty percent. Real wages showed a downward trend beginning in 2001, ending the seven year period with an increase of fourteen percent.

FIGURE 7
BIOTECHNOLOGY & PHARMACEUTICALS
Percentage Change in Employment and Wages*



[16] "The Health Care Technology Cluster in San Diego." Collaborative Economics, Inc. Draft report April 20, 1995. Page 2.

FIGURE 8
BIOTECHNOLOGY AND PHARMACEUTICALS CLUSTER DEVELOPMENT IN THE SAN DIEGO REGION



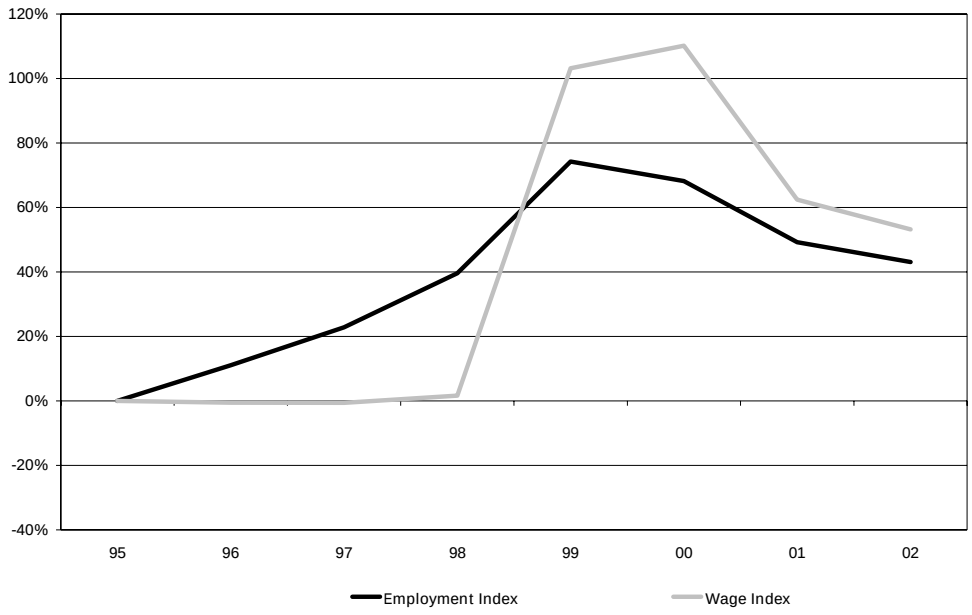
Source: BioCom, San Diego, prepared by SANDAG.

Communications

The Communications cluster includes sectors primarily engaged in researching and manufacturing communications-related products. The cluster also includes sectors that provide point-to-point communications services such as cellular and digital phone and pager services. Examples of cluster products include cellular and digital phones, fax machines, and encryption devices. The Communications cluster was one of the region's first large emerging-growth, high-technology clusters. The development of the Communications cluster can be traced back to its beginning at UCSD, as seen in Figure 10. The cluster's evolution began in 1968 with Linkabit Corporation, leading to the creation of Sciquest, Comstream, and eventually Qualcomm. As Qualcomm became one of the world's leading communication firms, numerous other companies, such as PCSI, Tiernan, and CommQuest opened their doors in the region. Today, the San Diego Communications cluster is one of the most prominent in the nation.

As shown in Figure 9, from 1995 to 2002 employment and real wages in the cluster increased forty-three and fifty-three percent, respectively.[17] Communications displays the most fluctuation amongst the Science and Technology clusters. Beginning in 2000, employment levels have fallen slightly, which can partially be explained by the transition to the new state employment classification system (NAICS).[18] Also, stock options contributed to the significantly higher average wages for this cluster in 1999 and 2000, which can be seen in the dramatic increase in the wage index.

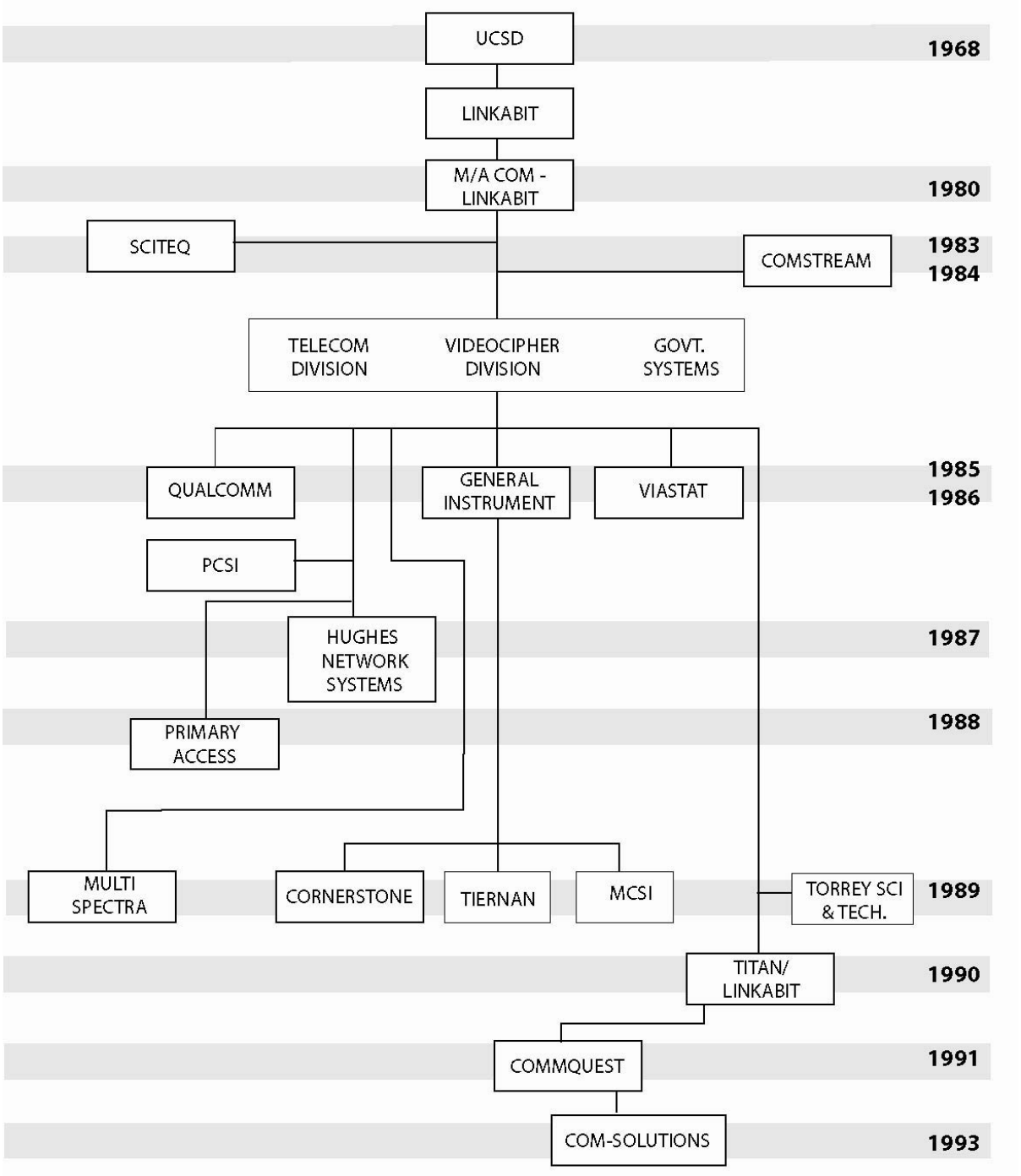
FIGURE 9
COMMUNICATIONS
Percentage Change in Employment and Wages*



[17] The Communications cluster includes full time employees of Qualcomm and other wireless firms in the region. Due to the multiple designations of Qualcomm's various departments in the employment data, and the fact that the wireless sector employs a high percentage of temporary workers, it is difficult to obtain an accurate employment count without directly surveying all firms in the region. A recently released report from the San Diego Workforce Partnership (WFP) on Temporary Workers in the region may hold some answers to these questions, although it was not released in time to be incorporated into this report. For more information, contact the WFP at http://www.workforce.org/.

[18] IN 2000, the format of the State's Employment data changed from Standard Industrial Classification (SIC) codes to the new North American Industrial Classification (NAICS) codes.

FIGURE 10
COMMUNICATIONS CLUSTER DEVLOPMENT
IN THE SAN DIEGO REGION



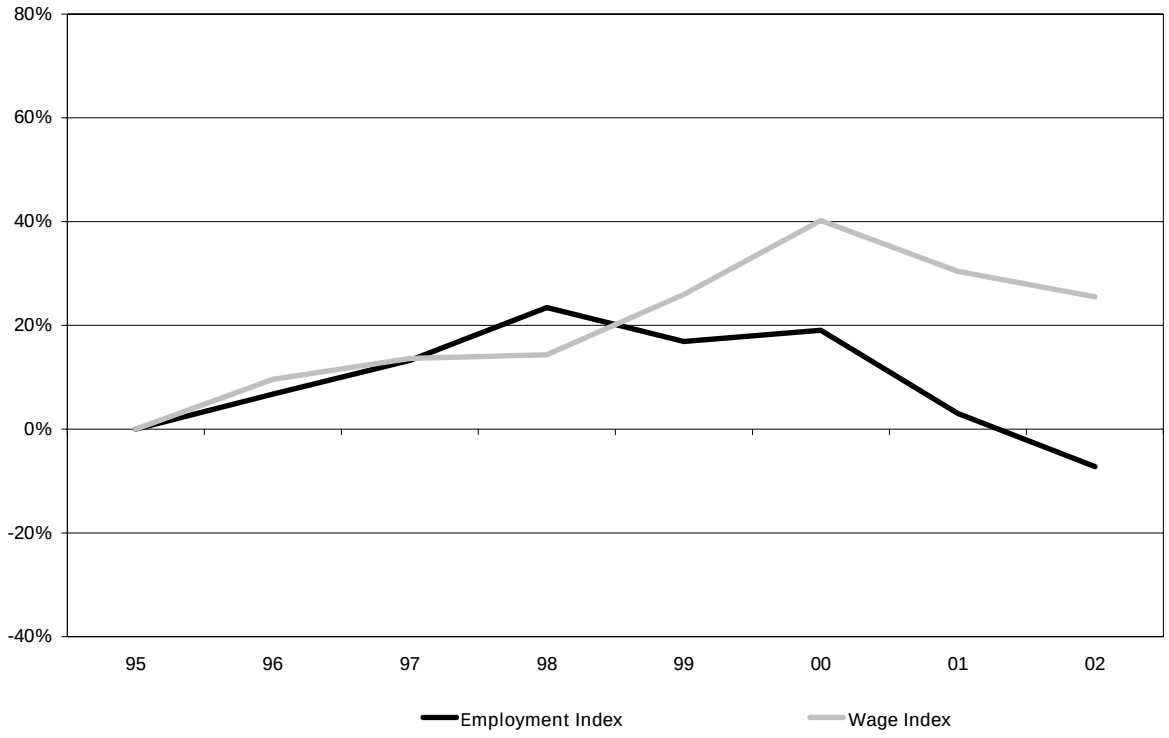
Source: CONNECT, UCSD, prepared by SANDAG.

Computer and Electronics Manufacturing

The Computer and Electronics Manufacturing cluster includes sectors that manufacture and assemble electronic components and products. The emphasis of this cluster is on high technology and computer-related products and their input components. Cluster products include speaker systems, printed circuit boards, and computer terminals. The Computer and Electronics Manufacturing cluster plays a vital role in the regional economy because it produces essential input components for numerous high-tech sectors such as Biomedical Products, Communications, and Defense and Transportation Manufacturing.

As shown in Figure 11, from 1995 to 2002 real wages in the Computer and Electronics Manufacturing cluster increased over twenty-five percent, while employment declined seven percent. Until 2000, employment had grown almost twenty percent over the 1995 level, but has since fallen to seven percent below it.

FIGURE 11
COMPUTER AND ELECTRONIC MANUFACTURING
Percentage Change in Employment and Wages*

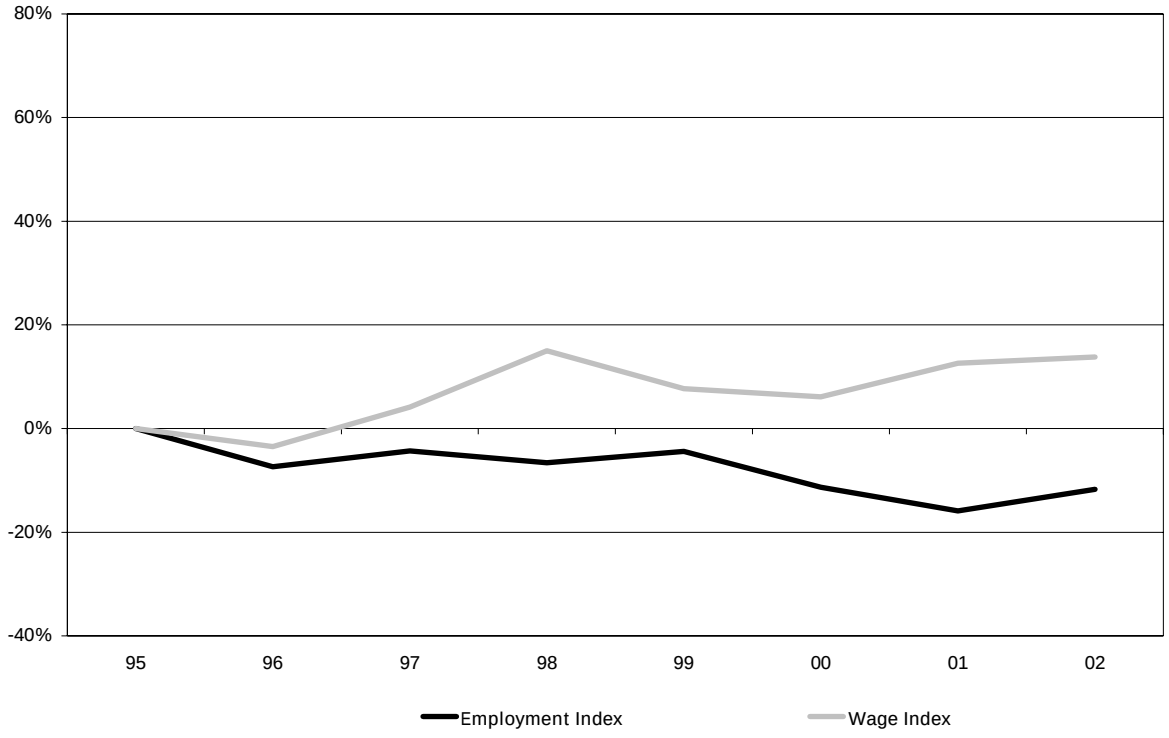


Defense and Transportation Manufacturing

The Defense and Transportation Manufacturing cluster includes sectors engaged in manufacturing or assembling aircraft, ships, boats, and defense related products such as guided missiles. As a result of decreased defense spending, some cluster businesses have been forced to diversify their product line to include commercial and high technology goods and services. Today's Defense and Transportation Manufacturing cluster's employment concentration is significantly higher than the national average and is still important to the region. Defense expenditures are on the rise again, increasing locally by more than thirty percent during the past year, from ten billion to thirteen billion dollars.[19]

As shown in Figure 12, this cluster experienced the largest employment decline of the Science and Technology clusters between 1995 and 2002, decreasing twelve percent. Real wages, on the other hand, have increased during this time period to nearly fifteen percent above wages in 1995. Recent trends in defense spending and federal policy should improve employment and wage opportunities in this cluster.

FIGURE 12
DEFENSE & TRANSPORTATION MANUFACTURING
Percentage Change in Employment and Wages*



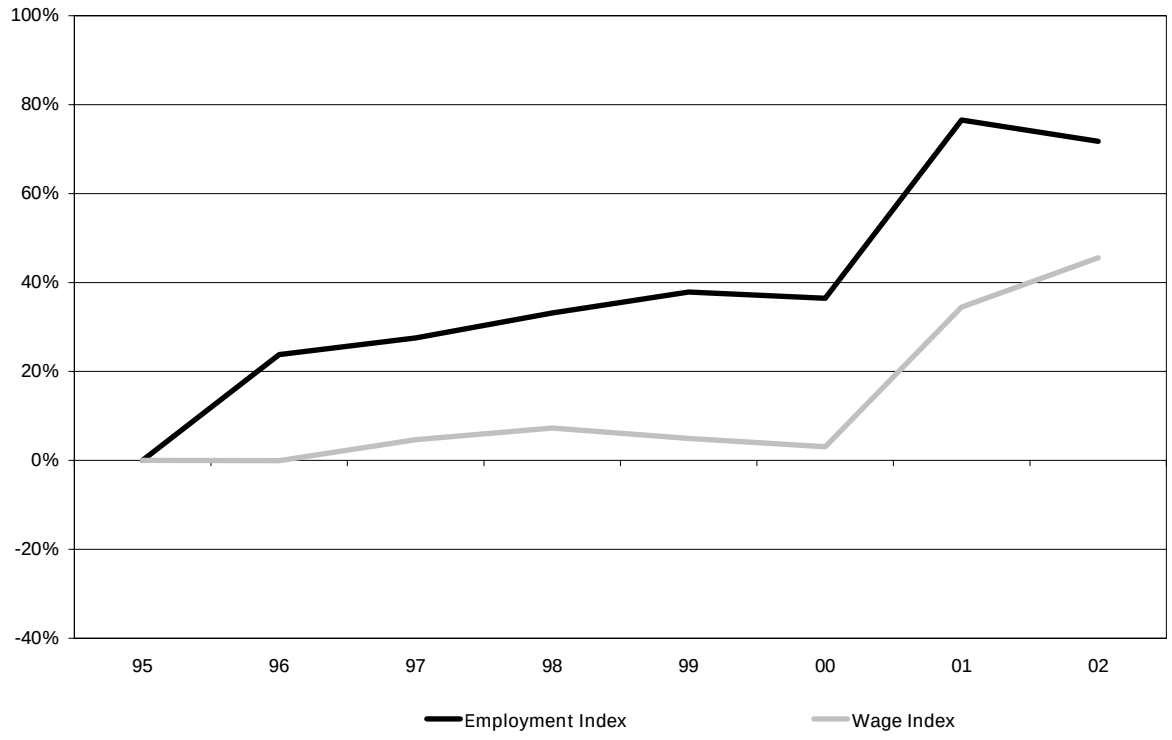
[19] San Diego Regional Chamber of Commerce Economic Bulletin, "Defense 2003," Volume 51, Number 7.

Environmental Technology

The Environmental Technology cluster is an emerging cluster that manufactures products with environmental applications. Examples of cluster specializations include: environmental engineering services; laboratory analysis; marine sciences; air and water filtration; environmental construction; and toxic, hazardous and radiological waste disposal and monitoring. Characteristic issues facing today's environmental marketplace include: water purification, pollution prevention and monitoring, waste disposal site renovation, and waste treatment and storage.

As shown in Figure 13, employment in the Environmental Technology cluster increased over seventy percent between 1995 and 2002, rising more than twenty-five percent since 2000. Real average wages during the seven year interval increased forty-six percent.

FIGURE 13
ENVIRONMENTAL TECHNOLOGY
Percentage Change in Employment and Wages*

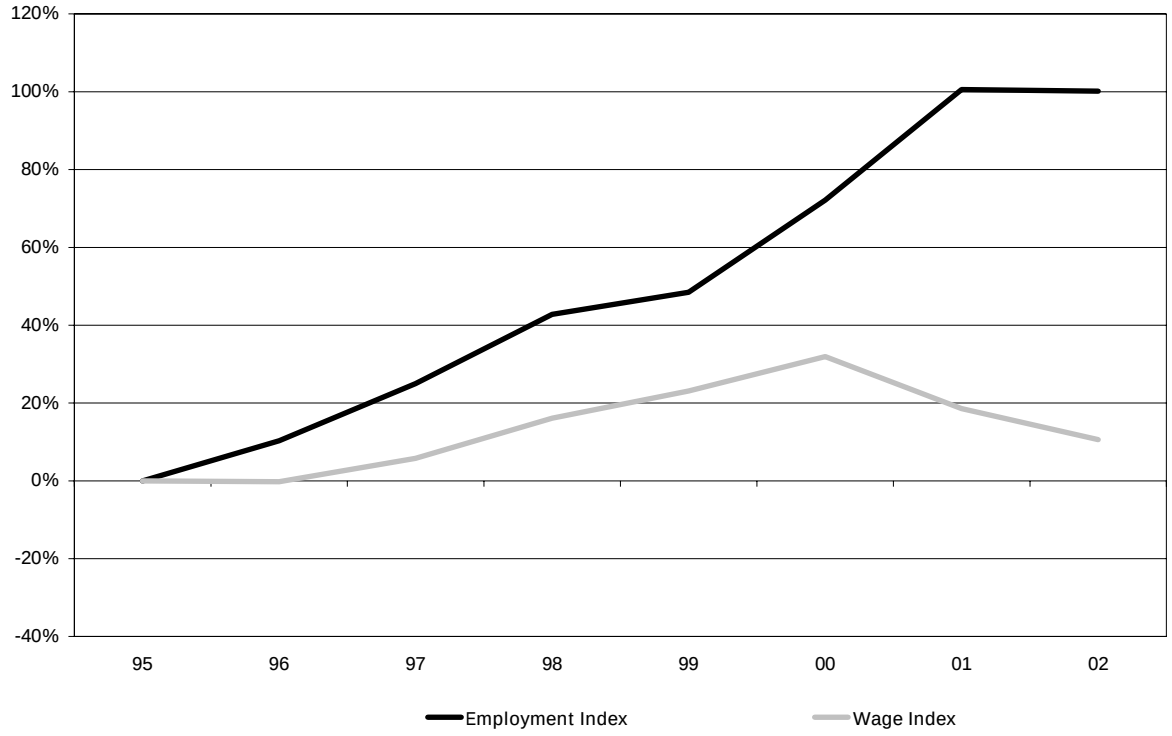


Software and Computer Services

The local Software and Computer Services cluster seems to have its roots in a relationship with the Defense industry. When defense spending decreased, Software firms adjusted their focus towards the commercial market and the cluster has now linked itself to most of the other high technology cluster sectors, providing products, services, and support to a wide range of companies. The Software and Computer Services cluster includes sectors that provide services such as computer programming, systems design and engineering, prepackaged software, software development, and computer training.

As shown in Figure 14, employment has risen steadily between 1995 and 2002, increasing one hundred percent. Real average wages increased eleven percent during the same period, rising until 2000 and falling slightly following 2001. The cluster grew quickly and now offers one of the highest average wages of the seven Science and Technology clusters.

FIGURE 14
SOFTWARE AND COMPUTER SERVICES
Percentage Change in Employment and Wages*



APPENDIX 2: TECHNICAL APPENDIX ON CLUSTER METHODOLOGY

Clusters are groups of inter-related industries that drive wealth creation in a region, primarily through export of goods and services. The use of clusters as a descriptive tool for regional economic relationships provides a richer, more meaningful representation of local industry drivers and regional dynamics than do traditional methods. SANDAG believes that in order for policy makers to commit to using cluster-based data for planning and decision-making purposes, there must be an understandable, acceptable and replicable process or system in place. Thus, SANDAG has created a process that rigorously examines the composition of clusters in the San Diego region.

SANDAG's process is intended to set a standard for identifying and defining employment clusters, and to use the information for economic development planning and analysis. Three technical factors are important in determining which industries constitute a cluster. The three factors are based on characteristics common to all clusters: interdependent; export-oriented; wealth generating. More specifically, the three factors are the Employment Concentration Factor (ECF), the Cluster Dependency Factor (CDF), and the Economic Prosperity Factor (EPF). The factors provide the quantifiable information necessary to standardize the identification of clusters and their components.

EXPORT-ORIENTED…EMPLOYMENT CONCENTRATION FACTOR

The Employment Concentration Factor (ECF) is a location quotient[20] used to identify which industries export goods and services out of the region and bring wealth back into it. Essentially, ECFs are used to approximate an industry's export-strength. By employing more workers than the national average the industry is likely producing more goods and services than the region alone can consume; thus, the industries export the surplus product out of the region.

$$\text{Employment Concentration Factor (ECF)} = \frac{\text{(Cluster Employment / Total Regional Employment)}}{\text{(National Cluster Employment / Total National Employment)}}$$

If a cluster's ECF is greater than 1.0, the national average, it can be assumed that some portion of its production is exported out of the region. For example, if a cluster's Employment Concentration Factor is 2.8, as it is for the Biotechnology and Pharmaceuticals cluster, it would mean that employment in this particular group is more than two and a half times more concentrated in the region than for the nation as a whole. Table 4 lists the ECFs for the seven Science and Technology clusters.

[20] A location quotient serves as a proxy calculation for identifying which industries export their goods and services out of the region.

TABLE 4
SnT CLUSTERS EMPLOYMENT CONCENTRATION FACTORS (ECF)
SAN DIEGO REGION, 2002

	ECF
Biomedical Products	1.63
Biotechnology and Pharmaceuticals	2.80
Communications	1.72
Computer and Electronics Manufacturing	2.20
Defense and Transportation Manufacturing	2.21
Environmental Technology	2.17
Software and Computer Services	1.36

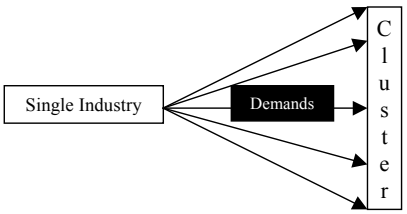
Source: 2002 EDD ES 202 data, compiled by SANDAG using 2000 Cluster definitions.

INTERDEPENDENT...CLUSTER DEPENDENCY FACTOR

Cluster businesses are highly inter-related, buying and supplying from one another. In order to quantify the relationships between businesses within a cluster, SANDAG developed cluster dependency factors using an Input-Output (I-O) model. This model is an economic tool used to determine the impacts of events on the local economy based on interindustry relationships. Constructed from employment and transactions data, the I-O model represents the flow of goods and services between employment sectors. Using the I-O model, it is possible to determine the strength of a cluster's internal relationships as well external relationships (with other clusters or businesses in the region). The model also reveals the structure of the cluster and quantifies the interdependency between the businesses that, taken collectively, make up the cluster.

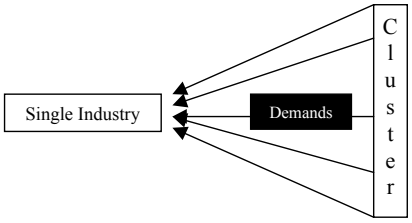
There are two Dependency Factors: CDF (Cluster) and CDF (Industry). Cluster Dependency Factors are calculated two ways: industry to cluster and cluster to industry. CDF (Cluster) measures the cluster's aggregate demand on a single industry; for example, the Computer and Electronics Manufacturing cluster's demand on the printed circuit board industry. CDF (Industry) represents a single industry's demand on the other members of the cluster: for example, the printed circuit board industry's demand on the Computer and Electronics Manufacturing cluster.

$$\text{Cluster to Industry Factor CDF (Cluster)} = \frac{\text{Sum of Cluster Demands on Single Industry}}{\text{Number of Industries in Cluster}}$$



Industries within a cluster place much stronger demands on one another, i.e. show higher transaction values, than they do on industries outside of the cluster group. CDF (Cluster) is determined by comparing the economy's average demand on a single industry and the average cluster demand on that single industry. Only industries that exhibit the highest transaction values with the cluster are included in the cluster definition. For example, the Computer and Electronics Manufacturing cluster's relationship with the printed circuit board industry reveals a very high transaction value.

$$\text{Industry to Cluster Factor CDF (Industry)} = \frac{\text{Sum of Single Industry Demand on Cluster}}{\text{Number of Industries in Cluster}}$$



CDF (Cluster) represents only half of a cluster's buyer-supplier relationship. The other half, CDF (Industry), is determined by comparing a single industry's demand on a cluster and the average demand by the economy on that cluster. If the cluster displays a high transaction value, or demand, with the single industry, the industry is included in the cluster definition. The printed circuit board industry places an above average demand on the Computer and Electronics Manufacturing cluster.

WEALTH GENERATING...ECONOMIC PROSPERITY FACTOR

The final step in identifying and defining the region's clusters is to determine which of them provide high-paying job opportunities. This helps economic development professionals prioritize their resources. The high-paying industries are identified through the Economic Prosperity Factor (EPF). The EPF is a measure of a cluster's contribution, in terms of payroll, to the local economy.

$$\text{Economic Prosperity Factor (EPF)} = \frac{\text{(Annual Cluster Payroll / Cluster Employment)}}{\text{(Total Regional Payroll / Total Regional Employment)}}$$

If the EPF ratio is greater than one, the industry has an average wage greater than that of the region. For example, the Software and Computer Services cluster has an Economic Prosperity Factor of 2.08. This means that the cluster's wages are more than two times higher than the regional average.